

Antibiotic use and misuse: A cross-sectional study assessing the understanding of Saudi medical students

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ABSTRACT

Background: Antibiotic resistance (AMR) has emerged as a global public health concern, posing a significant economic and clinical impact on both individual and population health. The current state of antibiotic resistance is frequently blamed on its overuse and misuse. Therefore, this study was aimed to explore the knowledge and attitude of medical students from four different governmental universities in Riyadh. **Methodology:** This was a cross-sectional survey of 692 undergraduate medical students in each year group from four governmental universities in Riyadh city. **Results:** A total of 692 participants were from the four best universities of Riyadh retorted to the questionnaire with a response rate of 99%. The majority of the respondents were females (52%). Considering students' knowledge toward using antibiotic medications, we found that 73.1 % of participants had adequate knowledge where 94.9 % of students knew that antibiotics are used for bacterial infections. Furthermore, we found that 15 % of students would keep antibiotics at home to be used in an emergency for children while 13.8 % would use antibiotics as a preventive medication even with no signs or symptoms. **Conclusion:** We found that medical students in the Riyadh region had adequate knowledge about the usage of antibiotics and reasons for antibiotics resistance however, we notice some shortcoming including low knowledge about antibiotic-related sensitivity, not completing the course of the treatment, and for viral infection and using of antibiotic as preventable medications. More study on this subject, including prescription practices and antibiotics, is needed.

Keywords: Antibiotics, Antibiotic resistance, knowledge and attitude, Saudi Arabia

1. INTRODUCTION

Antibiotics have always been called the "magic bullet"; however, these magic bullets weren't always so magical that they managed to withstand some serious flaws. Antibiotic usage and maltreatment result in selection pressure,

which leads to the evolution of resistance characteristics in bacterial populations (Fischbach and Walsh, 2009). The issue, however, was not with antibiotics were and continue to be one of the most successful weapons in the fight against illness. In actuality, the issue is drug abuse. Excessive or irrational use of antibiotics can not only lead to the emergence of resistant bacterial strains but also lead to side effects (Zakirulla et al. 2019; Nazari et al. 2020) and economic burdens on the national health system (Gyssens, 2001). Antibiotic use can be affected by a multitude of causes, including the availability of unregulated drugs, relaxed health policies regarding regulations for antibiotic use, availability of over-the-counter drugs, and patient knowledge and attitudes. Towards antibiotics, self-medication, physician knowledge and experience, patient-prescriber interactions, and students can play a critical role in reducing inappropriate use of antibiotics. In this respect, in the literature, there are a rising number of study publications, directed their attention to knowledge, attitudes, and practice screening for medical and non-medical students toward the use of antibiotics.

In China, 2,500 medical and non-medical students were polled. Showed that medical students perform in terms of antibiotics usage knowledge and attitudes outperform non-medical students (Huang et al., 2013). Similar to this research, another study conducted among doctors and paramedics possess a moderate level of confidence regarding usage of antibiotics, adequate knowledge was reported in about third- and quarter-of pharmacy students, but poor attitudes of pharmacy students about antibiotic use have been reported (Ganesh et al., 2012; Dhingra et al., 2015). Multiple Indian studies conducted among students have reported poor knowledge of antibiotic spectrums, indications, side effects, and their improper use (Satish et al., 2011; Arul et al., 2011). Another study revealed a good understanding and awareness of antibiotic resistance among the students of pharmacy and medicine (Jamshed et al., 2014; Haque et al., 2019). One US study showed that antimicrobial knowledge is vital for doctors, according to 92% of medical students, and 90% want additional instruction on how to use them safely (Abbo et al., 2013). Several European studies have also shown that antimicrobial prescription is an area where medical students typically lack confidence (Dyar et al., 2014; Brinkman et al., 2017).

Medical students must learn how to prescribe drugs safely and effectively because, once graduating and licensed to practice as doctors, with initial guidance and training they will be prescribing medicines daily. Patient benefits, treatment adherence, and low-cost healthcare burden are usually based on rational and wise prescribing skills. Despite the fact that medical students are the future physicians, a handful of research has been undertaken among Saudi Arabian medical students. According to the findings of a prior research, awareness of using the antibiotics and assess the importance of antibiotic resistance. Antibiotics are frequently used to treat illnesses that do not require a prescription in the community (Alghadeer et al., 2018; Zaidi et al. 2020).

As a result, the goal of this research is to learn more about their antibiotic use, knowledge, and attitudes, as well as the variables that influence AMR, such as once they feel better, they stop taking antibiotics and save the rest for later and utilizing left over antibiotics without contacting a doctor.

2. SUBJECTS AND METHODS

Study design and setting

Following the previously published reports with necessary adjustments, a systematized questionnaire was created to conduct this study. The dependent variable was the antibiotics use and misuse, and the other factors were taken as independent variables. The research was conducted in two parts; the initial test was as a pilot study to provide valuable validation of the content of the major questionnaire study. The questionnaire survey was double-checked and updated to address any issues that arose during the pilot research. The second part was a large-scale research project aimed at achieving the goal of the survey and was distributed among the four governmental universities in Riyadh city Imam Muhammad ibn Saud Islamic University (IMSIU), King Saud bin Abdulaziz University for health sciences (KSAU-HS), King Saud University (KSU) and Princess Nourah Bint Abdulrahman University. The survey was carried out over a three-month period from December to February 2020. The purpose of this study was briefly explained at the beginning of the questionnaire. The ethical research committee of the Institutional Review Board (IRB) Registration in Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia has approved this study.

Data collection

An online Google form questionnaire (Google LLC, Mountain View, CA) link was shared with undergraduate medical students. Encouraged participants were to share the questionnaire link among their colleagues; hence, the questionnaire could reach many participants. Students from 1st to 5th-year aged 18 to 30 years have been included in the research. The questionnaire has four sections: demographic, basic knowledge about antibiotics, students' practice toward using antibiotics, and knowledge of students toward antibiotic resistance.

The first section of the questionnaire was made up of the sociodemographic questions. Age was one of the factors included in the survey questionnaire for this study, gender, year of study, GPA, and any relatives working in the health field. The questionnaire second component was created to study to evaluate the students' basic knowledge about antibiotics and their use, knowledge of students toward antibiotic resistance with close-ended questions that include what the purpose of antibiotics is, does it kill microflora, allergic reaction of antibiotics uses, and antibiotics used for inflammation. In the third section, there was seven statements about the students' practice toward using of the antibiotic section, and in the last section of questionnaire we have included the knowledge of students toward Antibiotic resistance Before filling out the questionnaire, the students were informed about the study and provided directions on how to complete the survey completely and truthfully and that their participation would be voluntary, and their anonymity would be assured.

Data Management and Analysis

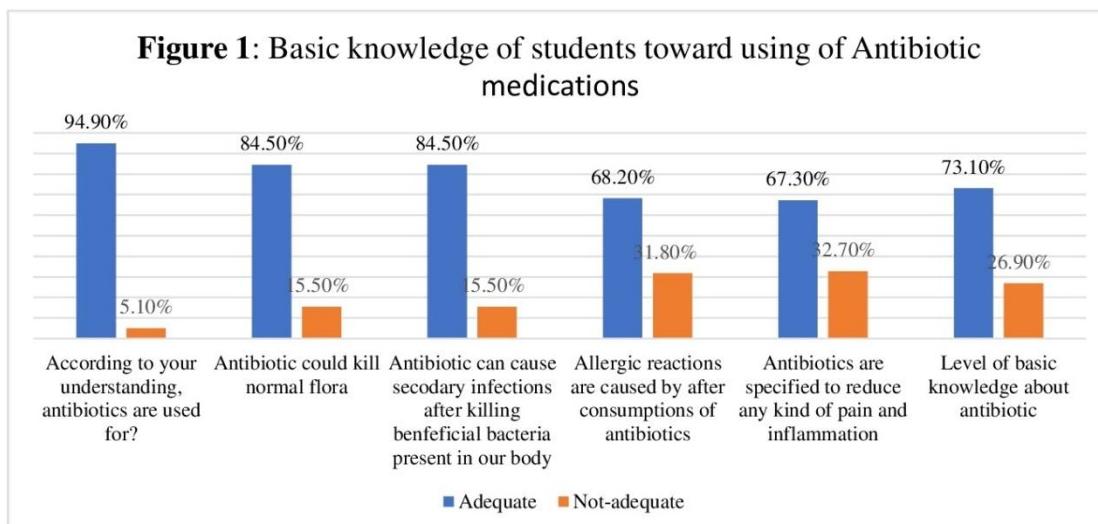
MS Excel was used for data entry, and exclusion of participants with exclusion criteria was conducted. Then, data were coded, and SPSS version 24 was used to analyse the data. For categorical data, frequency and percent were utilized like age, gender, and basic knowledge about antibiotics, students' practice toward using of antibiotic and while mean and standard deviations were used for continuous variables as scores of knowledge of students toward antibiotic resistance. Finally, Chi-test and t-test were conducted to understand the relation between demographic factors of participants and the prevalence to assess of antibiotics use and misuse. All statement was significant if the p-value was lower or equal to 0.05.

3. RESULTS

In this study, we were able to collect 692 responses for our questionnaire, of which 52 % were females and 97.8 % were single. This sample was collected from four different universities in the Riyadh region, Saudi Arabia, where 31.9 % of students were from King Saud University while 24 % were from Imam Muhammad Ibn Saud Islamic University and 22.4 % and 21.7 % from Princess Nourah Bint Abdulrahman University and King Saud bin Abdulaziz University for health sciences. Moreover, 29.5 % of students were in the second year, and 57.4 % of them indicated having a GPA of more than 4.5 in the last year, while 61.7 % of them indicated having relatives who were working in the realm of medicine (Table 1).

		Table 1 Demographic factors of participants (N=692)	
		Frequency	Percent
Gender	Male	332	48.0%
	Female	360	52.0%
Marital status	Single	677	97.8%
	Married	11	1.6%
University	Divorced	4	0.6%
	Imam Muhammad Ibn Saud Islamic University	166	24.0%
	King Saud bin Abdulaziz University for health sciences	150	21.7%
	King Saud university	221	31.9%
	Princess Nourah Bint Abdulrahman University	155	22.4%
Year of the study	First year	78	11.3%
	Second year	204	29.5%
	Third year	199	28.8%
	Fourth year	154	22.3%
	Fifth year	57	8.2%
Last year GPA	<4	91	13.2%
	4-4.5	204	29.5%
	>4.5	397	57.4%
Have relatives working in the health field	Yes	427	61.7%
	No	265	38.3%

Considering the knowledge of students about using antibiotic medications, we found that 73.1 % of participants had adequate knowledge where 94.9 % of students knew that antibiotics are used for bacterial infections and 84.5 % knew that antibiotics could kill normal flora, which could lead to secondary infections. However, 31.8 % of students did not know that antibiotics could cause allergic reactions and 32.7 % thought that antibiotics could be used to reduce any type of pain or inflammation (Figure 1).



Moreover, we found that maximum of the participants indicated that they rarely used antibiotics (81.5 %), mostly when prescribed by physicians (91.4 %) however, 4.5 % of participants indicated that there are specific antibiotics that they used when self-prescribed, including topical cream and broad-spectrum antibiotic as amoxicillin plus clavulanic acid. Moreover, we found that 10.8 % of participants would stop using of antibiotic when they felt better while 95.8 % would take them on time according to instructions and 17.9 % would use antibiotic which was leftover (Table 2).

Table 2 Students' practice toward using of antibiotic

		Count	N %
I use antibiotic	Rarely	538	81.5%
	Once every year	53	8.0%
	Once every 6 months	44	6.7%
	Once every 1-2 months	18	2.7%
	More than once a month	7	1.1%
Source of antibiotics	Doctor's prescription	603	91.4%
	Pharmacist	30	4.5%
	A relative	17	2.6%
	Self-prescription	10	1.5%
Is there a specific antibiotic you use when self-prescribed?	Yes	30	4.5%
	No	630	95.5%
Specify	Topical antibiotic cream	5	25.0%
	Oral antibiotics including Amoxicillin and clavulanic acid	15	75.0%
When do you stop the antibiotic?	After finishing the antibiotic course	589	89.2%
	When you feel better	71	10.8%
Do you take the antibiotics	Yes	632	95.8%

on time according to the instructions?	No	28	4.2%
Have you ever used leftover antibiotics?	Yes	118	17.9%
	No	542	82.1%

Furthermore, we found that most of the participants would use antibiotics when they had a fever because of bacterial infections, while other reasons for using antibiotics were when having a sore throat (33.2 %) and toothache (15.3 %). However, we noticed that there are a significant percentage of students who would misuse antibiotics for a toothache (15.3 %), general pain (8 %), and fever due to virus infection (Figure 2).

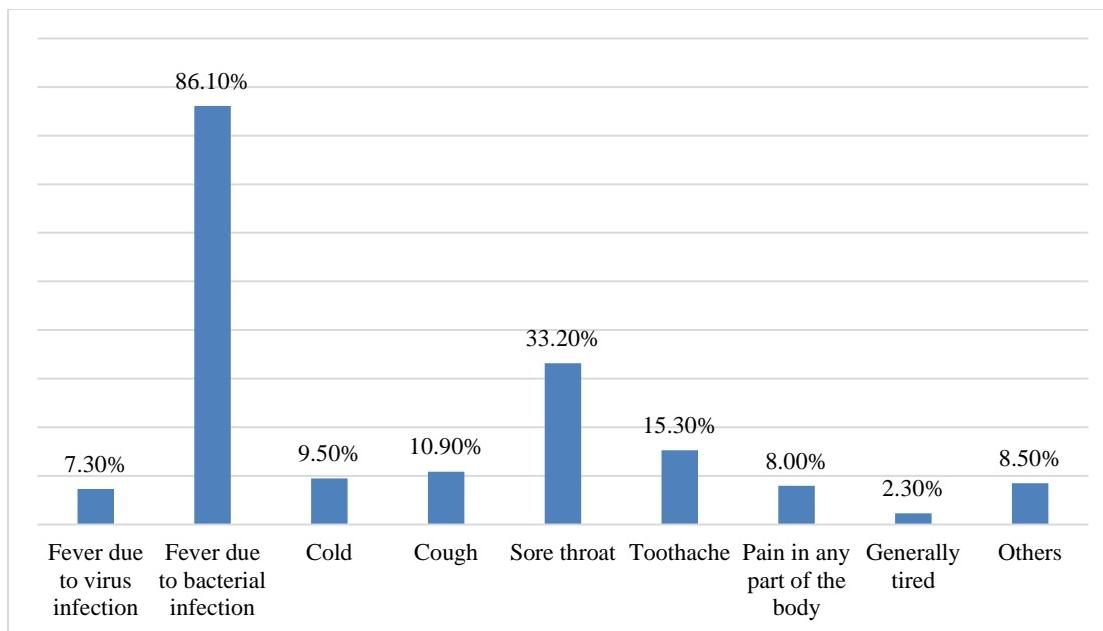


Figure 2 The reasons for using antibiotic according to students

Moreover, we found that 89.4 % of students indicated that they knew what antibiotic resistance means were 90.2 % of them correctly knew the definition of antibiotic resistance. The main reasons for antibiotic resistance according to students were using them when it was not needed (70.7 %) and not completing the course of treatment (67.1 %) while 6.4 % did not know (Table 3).

Table 3 Knowledge of students toward Antibiotic resistance

		Count	Column N %
Do you know what (antibiotic resistance) means?	No	70	10.6%
	Yes	590	89.4%
Antibiotics resistance is a phenomenon for which a bacterium loses its sensitivity to an antibiotic	No	65	9.8%
	Yes	595	90.2%
Reasons for antibiotic resistance	1. Using antibiotics when it's not needed	445	70.7%
	2. Not completing the full course of antibiotics	422	67.1%
	3. I don't know	40	6.4%

Furthermore, we found that 15 % of students would keep antibiotics at home to be used in an emergency for children while 13.8 % would use antibiotics as a preventive medication even with no signs or symptoms and 12.6 % had an antibiotic prescription via phone with no clinical examination. Moreover, most of the participants thought that antibiotics should be administrated as

prescribed considering when to use them. However, 64.5% of the participants would take it with water. Furthermore, we found that refrigerators and medicine cabinets were the main places to store antibiotics in the home. Considering using antibiotics during pregnancy, we found that 82.3 % of participants thought that antibiotics are not safe during pregnancy and 65.8 % of females thought that antibiotics could harm the baby's health and 19 % of them thought that antibiotics are safe to use during breastfeeding (Table 4).

Table 4 Attitude of students toward using antibiotic in different situations

		Count	Column N %
Do you keep antibiotics at home as an emergency treatment for children?	No	561	85.0%
	Yes	99	15.0%
Would you take antibiotics as a preventive treatment before any signs or symptoms appear	No	569	86.2%
	Yes	91	13.8%
Have you ever had an antibiotic prescription via phone with no clinical examination	No	577	87.4%
	Yes	83	12.6%
When do you take antibiotics	Before meals	11	1.7%
	With the meal	16	2.4%
	After meals	112	17.0%
	Before or after meals	9	1.4%
	According to instructions	512	77.6%
How do you take antibiotics	water	426	64.5%
	Juice	2	0.3%
	Coffee, tea	8	1.2%
	According to instructions	219	33.2%
	Other	5	0.8%
How do you store antibiotics	Medicine cabinet	275	41.7%
	Kitchen	41	6.2%
	Refrigerator	289	43.8%
	Other	0	0.0%
	5.00	55	8.3%
Do you think that antibiotics are safe to use during pregnancy	Yes	70	17.7%
	No	325	82.3%
	I do not know	0	0.0%
Do you think that antibiotics are safe to use during breastfeeding	Yes	75	19.0%
	No	320	81.0%
	I do not know	0	0.0%
Do you think using antibiotics during pregnancy might harm the baby's health?	Yes	434	65.8%
	No	226	34.2%
	I do not know	0	0.0%

Moreover, we found that level of knowledge about antibiotics was significantly different between genders, where 76.5 % of males had adequate knowledge compared with 70 % of females ($p=0.004$). Moreover, we found that students of King Saud University had the highest percentage of students with adequate knowledge, followed by students of King Saud bin Abdulaziz University for Health Sciences ($P=0.001$). Finally, we found that students of the first year had the lowest percentage of students having adequate knowledge with 51.3 % ($P=0.000$) (Table 5).

Table 5 The relation between demographic factors of students and their knowledge toward using antibiotic

		Level of basic knowledge about antibiotic		Do you know what (antibiotic resistance) means?	
		Adequate	Not adequate	No	Yes
Gender	Male	76.5%	23.5%	10.7%	89.3%
	Female	70.0%	30.0%	10.5%	89.5%
	P-value	0.004*		0.936	
University	Imam Muhammad Ibn Saud Islamic University	67.5%	32.5%	12.8%	87.2%
	King Saud bin Abdulaziz University for health sciences	78.0%	22.0%	10.4%	89.6%
	King Saud university	80.1%	19.9%	7.4%	92.6%
	Princess NourahBint Abdulrahman University	64.5%	35.5%	13.1%	86.9%
	P-value	0.001*		0.257	
	Firstyear	51.3%	48.7%	9.6%	90.4%
Year of the study	Secondyear	81.9%	18.1%	8.4%	91.6%
	Thirdyear	74.9%	25.1%	10.4%	89.6%
	Fourthyear	70.8%	29.2%	10.0%	90.0%
	Fifthyear	71.9%	28.1%	23.1%	76.9%
	P-value	0.000*		0.046*	

4. DISCUSSION

Antibiotics are prescribed in the management of several diseases, especially those caused by bacterial infections (Lieberman 2003; Aminov, 2010). However, during the last decades, the world witnessed a great increase in the cases of microbial resistance that resulted from the uncontrolled and misuse of antibiotics and has a significant negative impact on health, economic burden, prolonged hospital stays, higher mortality rates (Penchovsky and Traykovska, 2015; Lee 2015). Moreover, there is very little information available regarding the level of knowledge and awareness toward antibiotic therapy among medical students of many Arab countries (Shehadeh et al., 2012). The purpose of this research was to find out more about usage, knowledge, and attitude regarding antibiotics among medical students in Riyadh region, Saudi Arabia.

According to our research, we found that almost two-third of the students had adequate knowledge considering the uses of antibiotics where 94.9 % of them knew that antibiotics are used for bacterial infections. This finding is comparable to those among medical students finding that 96.5 % of students knew that antibiotics could be used for bacterial infection (Kanneppady et al., 2019). However, our results were better than reported by Jairoun et al., (2019) where the authors reported that 91.4 % of the sample knew that antimicrobial is used for bacterial infection. However, we notice that almost a third of the students did not know that antibiotics could cause an allergic reaction and could be used for any type of pain or inflammation. A multicenter study among Egyptian medical students showed that 35.7 % who polled thought bacteria were to blame for the common cold and influenza (Assar et al., 2020). The last defect is significant because the belief that antibiotics could be used for pain would lead to misuse of antibiotics in medical conditions in which no need for antibiotics. Moreover, antibiotic-related allergic reactions could be fatal in some cases (Kim and Lee, 2014). Thus, awareness of physicians of its incidence is significantly important.

In our study, we found that most of the participants rarely used antibiotics during the last year. In another study conducted among the general population, the author found that 50.3 % of participants indicated using antibiotic more than five times per year (Huwaymil et al., 2017) indicated that the usage of antibiotic in our study is limited. Furthermore, in our study, we found that the main source of administration of antibiotics was by prescribing them through a physician. This could be due to the rule of Saudi Arabia that restricted the dispensing of antibiotics without prescription. In our data, the prevalence of self-prescribing of antibiotic was 4.5%, which is one of the most commonly known cause of antibiotic resistance as well as overuse and misuse of these medications (Lee, 2015). In our results, we found that most of the students correctly knew what antibiotic resistance means and

could understand its causes. Similar to a study conducted at Malaysia's Lincoln University College, showed that majority of participants were aware of antibiotic resistance. Comparing to another study which was also conducted on medical students showed that 29.2% of students still use antibiotics without prescription (Haque et al., 2019). However, 10.8 % of participants would stop using of antibiotic when they felt better. This result is similar to the results of a study conducted among Saudi medical students (Afify et al., 2020).

Moreover, we found that most of the students would use antibiotics in case of having fever with a bacterial infection, comparable to the research done at Umm Al-Qura University. Where as 39% of their participants contemplated using antibiotics to treat their fever (Afify et al., 2020). However, we found that some students would misuse antibiotics for another purpose as for pain, viral infection, and toothache, which indicated mis-awareness by the uselessness of antibiotic in these situations. A comparable study from Nigeria indicated that about a third of the medical students (34.2%) were confused about whether antibiotics were effective against bacteria or viruses (Alex, 2019), and a similar response was observed in a Chinese study (Huang et al., 2013). Antibiotics do not treat viral infections, according to (35.5 %) of responders. We also found that level of knowledge about antibiotic was significantly different between genders where males were found to have a higher level of knowledge which is different than what was reported in many studies where it is found that females had a significantly higher level of knowledge studies (Alshibani et al., 2017; Byrne et al., 2019). Level of education is another significant factor that affects the level of knowledge where it was found in our study that students of the first year had the lowest level of knowledge which is similar to other studies (Dhingra et al., 2015; El Sherbiny et al., 2019) and is reasonable where students of the first year do not have the complete knowledge about the mechanism of antibiotic and how it is work.

This study had some limitations. One of these limitations is depending on a self-reported questionnaire, which may lead to some personal bias where some students may not be fully honest in completing the questionnaire. Moreover, depending on the online method in the distribution of the questionnaire may lead to sampling bias toward younger students and students who feel more confident to answer the questionnaire correctly, which may cause in increasing the percent of students who have adequate knowledge about uses of antibiotic.

5. CONCLUSION

This research makes a helpful recommendation and suggests that by broadening knowledge of antibiotics usage and limit the development of resistance. Our study key findings revealed that medical students of Riyadh had high level of knowledge of antibiotics and their use and also aware about antibiotic resistance. But more investigations should be conducted in different universities in order to generalize the results over the kingdom. Our findings provide evidence base to campaign in reduction of inappropriate using of antibiotics, and its findings can be used to appraise the strategy of effective and misunderstandings on antibiotic usage and to raise awareness about the dangers of improper use. Future studies should start focusing on the development and implementation at the national and regional levels to improve antibiotic use among Saudi community.

Declaration

Author's Contributions

AA, KA and RA contributed to the design, prepared the study protocol and questionnaire. AA, KA, IA, YA, BA and RA contributed to the data collection, analysis and interpretation of the result. AA, KA, JA and RA contributed to drafting of the manuscript. JA, JK and RA contributed to preparing, reviewing and editing the manuscript. All authors approved the final version of the manuscript.

Conflicts of interest

The authors declare that they have no conflict of interest.

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Ethical approval

The Institutional Review Board (IRB) of Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia, authorized this study's ethical research committee (HAPO-01-R-001, Project No. 125-2020, session no. 39). All participants in the research gave their verbal and written informed permission.

Data Availability

All datasets generated or analysed during this study are included in the manuscript.

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Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Abbo LM, Cosgrove SE, Pottinger PS, Pereyra M, Sinkowitz-Cochran R, Srinivasan A, Webb DJ, Hooton TM. Medical Students' Perceptions and Knowledge About Antimicrobial Stewardship: How Are We Educating Our Future Prescribers? *Clin Infect Dis* 2013. doi.org/10.1093/cid/cit370
2. Afify M, AlsaidiA, AlmatrafiN, AlhazmiA, AlzahraniA, Alhakami T, AlhasaniM. Awareness level of second, third and fourth year medical students toward antibiotic resistance. *Int J Med Develop Countries* 2020. doi: 10.24911/IJMDC.51-1583174128
3. Ahmad A, Khan MU, Patel I, Maharaj S, Pandey S, Dhingra S. Knowledge, attitude and practice of B.Sc. Pharmacy students about antibiotics in Trinidad and Tobago. *J Res Phar Pract* 2015. doi: 10.4103/2279-042X.150057.
4. Alex IO, Madubueze UC, Umeokonkwo CD, Oka OU, Adeke AS, Okeke KC. Knowledge of antibiotic use and resistance among students of a medical school in Nigeria. *Malawi Med J* 2019. doi: 10.4314/mmj.v31i2.5.
5. Alghadeer S, Aljuaydi K, Babelghaith S, Alhammad A, Alarifi MN. Self-medication with antibiotics in Saudi Arabia. *Saudi Pharm J* 2018. doi: 10.1016/j.jps.2018.02.018.
6. Al-Shibani N, Hamed A, Labban N, Al-Kattan R, Al-Otaibi H, Alfadda S. Knowledge, attitude and practice of antibiotic use and misuse among adults in Riyadh, Saudi Arabia. *Saud Med J* 2017. doi: 10.15537/smj.2017.10.19887
7. Aminov RI. A Brief History of the Antibiotic Era: Lessons Learned and Challenges for the Future. *Front Microbiol* 2010. doi: 10.3389/fmicb.2010.00134
8. Arul KC AP, Kumar N, Ramesh J. Students' knowledge of antibiotics: A crosssectional study of students in Tamil Nadu. *Int J Pharm Pharm Sci* 2011; 3(1):232-233
9. Assar A, Abdelraoof MI, Abdel-Maboud M, Shaker KH, Menshawy A, Swelam AH, Eid M, Khalid R, Mogahed M, Abushouk AI, Aleya L, Abdel-Daim M. Knowledge, attitudes, and practices of Egypt's future physicians towards antimicrobial resistance (KAP-AMR study): a multicenter cross-sectional study. *Environ Sci Pollut Res Int* 2020. doi: 10.1007/s11356-020-08534-5
10. Brinkman DJ, Tichelaar J, Schutte T, Benemei S, Böttiger Y, Chamontin B, Christiaens T, Likic R, Maciulaitis R, Marandi T. Working Group Research on CPT Education of the European Association for Clinical Pharmacology and Therapeutics (EACPT). Essential competencies in prescribing: A first European cross-sectional study among 895 final-year medical students. *Clin Pharmacol Ther* 2017. doi.org/10.1002/cpt.521
11. Byrne MK, Miellet S, McGlinn A, Fish J, Meedya S, Reynolds N, Oijen AM. The drivers of antibiotic use and misuse: the development and investigation of a theory driven community measure. *BMC Pub Health* 2019. doi: 10.1186/s12889-019-7796-8.
12. Dyar OJ, Pulcini C, Howard P, Nathwani D. ESGAP (ESCMID Study Group for Antibiotic Policies). European medical students: A first multicenter study of knowledge, attitudes, and perceptions of antibiotic prescribing and antibiotic resistance. *J Antimicrob Chemother* 2014. doi: 10.1093/jac/dkt440.
13. El Sherbiny NA, Ibrahim EH, Masoud M. Alexandria Journal of Medicine Assessment of knowledge, attitude and behavior towards antibiotic use in primary health care patients in Fayoum Governorate, Egypt Assessment of knowledge, attitude and behavior towards antibiotic use in primary health care patients in Fayoum Governorate, Egypt. *Alexandria J Med* 2018. doi.org/10.1016/j.ajme.2018.06.001
14. Fischbach MA, Walsh CT. Antibiotics for Emerging Pathogens. *Science* 2009. doi:10.1126/science.1176667
15. Ganesh M, Sridevi SA, Paul CM. Antibiotic use Among Medical and Para Medical Students: Knowledge, Attitude and its Practice in a Tertiary Health Care Centre in Chennai- a Scientific Insight. *Intl J Sci Res* 2012. doi: 10.36106/ijsr
16. Gyssens IC. Quality measures of antimicrobial drug use. *Int J Antimicrob Agent* 2001. doi:10.1016/S0924-8579(00)00208-9

17. Haque M, Rahman NAA, McKimm J, Sartelli M, Kibria GA, Islam MZ, Lutfi SNN, Othman NSA, Abdullah SL. Antibiotic Use: A Cross-Sectional Study Evaluating the Understanding, Usage and Perspectives of Medical Students and Pathfinders of a Public Defence University in Malaysia. *Antibio* 2019. doi:10.3390/antibiotics8030154
18. Huang Y, Gu J, Zhang M, Ren Z, Yang W, Chen Y, Fu Y, Chen X, Cals JW, Zhang F. Knowledge, attitude and practice of antibiotics: a questionnaire study among 2500 Chinese students. *BMC Med Edu* 2013. doi:10.1186/1472-6920-13-163
19. Huwaymil MS, Alkhailah MA, Alfaris MA, Alsaqabi OA, Alhabshan RF, Alzaid AN. Assessment of Knowledge, Attitudes and Practices regarding Pulmonary Tuberculosis among Community in Riyadh City, 2017. *Egypt J Hosp Med* 2017. doi: 10.12816/0041686
20. Jairoun A, Hassan N, Ali A, Jairoun O, Shahwan M, Hassali M. University students' knowledge, attitudes, and practice regarding antibiotic use and associated factors: a cross-sectional study in the United Arab Emirates. *Int J Gen Med* 2019. doi: 10.2147/IJGM.S200641
21. Jamshed SQ, Elkalmi R, Rajiah K, Al-Shami AK, Shamsudin SH, Siddiqui MJ, Abdul Aziz MK, Hanafi MB, Shariff NIM, Ramlan NH, Jamil N, Mustapha NA, Yusri NH, Shahri NA, Ismail R, Zamri SM. Understanding of antibiotic use and resistance among final-year pharmacy and medical students: a pilot study. *J Infect Dev Ctries* 2014. doi: 10.3855/jidc.3833.
22. Kanneppady SS, Oo AM, Lwin OM, Ahmed Al-Abed AAA, Kanneppady SK. Knowledge, attitude, and awareness of antibiotic resistance among medical students. *Arch Med Health Sci* 2019; 7:57-60
23. Kim MH, Lee JM. Diagnosis and Management of Immediate Hypersensitivity Reactions to Cephalosporins. *Allergy Asthma Immunol Res* 2014. doi: 10.4168/aaair.2014.6.6.485
24. Lee Ventola C. The Antibiotic Resistance Crisis Part 1: Causes and Threats 2015; 40(4):277-83.
25. Lieberman JM. Appropriate antibiotic use and why it is important: the challenges of bacterial resistance. *Pediatr Infect Dis J* 2003. doi: 10.1097/01.inf.0000101851.57263.63.
26. Nazari P, Salehimanesh H, Izadpanah F, Moradi M. Antibiotic susceptibility of bacterial strains isolated from lower urinary tract infection in 2018 in Zabol: A cross-sectional study. *Medical Science*, 2020;24(102):725-733
27. Penchovsky R, Traykovska M. Designing drugs that overcome antibacterial resistance: where do we stand and what should we do? *Expert Opin Drug Discov* 2015. doi: 10.1517/17460441.2015.1048219
28. Satish KB, Santhosh YL, Ahamed MG, Naveen MR. Survey on knowledge towards antibiotics among the nursing students. *Int J Pharm Pharm Sci* 2011;3(2):227-229
29. Shehadeh M, Suaifan G, Darwish RM, Wazaify M, Zaru L, Alja'fari S. Knowledge, attitudes and behavior regarding antibiotics use and misuse among adults in the community of Jordan. A pilot study. *Saudi Pharm J* 2012. doi: 10.1016/j.jps.2011.11.005.
30. Zaidi SF, Alotaibi R, Nagro, A, Alsalmi M, Almansouri H, Khan MA, Khan A, Memon I. Knowledge and Attitude towards Antibiotic Usage: A Questionnaire-Based Survey among Pre-Professional Students at King Saud bin Abdulaziz University for Health Sciences on Jeddah Campus, Saudi Arabia. *Pharm* 2020. doi: 10.3390/pharmacy8010005.
31. Zakirulla M, Muraih AB, Al-whlan AA, Almerei OS, Al-zahrani RH, Alshahrani AB, Meer AB. Dental students' knowledge and practices regarding antibiotic prescribing guidelines in children in Abha, KSA: A crosssectional study. *Medical Science*, 2019;23(96):179-184